

Declaration of Dr. Rainer Schuhmann and Witold Hackemer
US Application Serial No. 09/598,406

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of:

Gerhard HOPPEN

Serial No.: 09/598,406

Examiner: A. Chang

Filed: June 21, 2000

Art Unit: 2872

Title: DUV-CAPABLE MICROSCOPE OBJECTIVE WITH PARFOCAL IR FOCUS

**DECLARATION (UNDER 37 C.F.R. § 1.132) OF DR. RAINER SCHUHMAN AND
WITOLD HACKEMER**

We, (a) Dr. Rainer Schuhmann and (b) Witold Hackemer,

declare and state as follows:

1.(a) I, Rainer Schuhmann, am currently employed as Vice President / Business Division Manager Industrial Manufacturing at LINOS Photonics GmbH & Co. KG and have worked at LINOS since 1989. During my tenure at LINOS, I have worked in the field of optical design, especially lens design. I also worked as Director of the R&D Department and Quality Management for LINOS. Prior to that, I was employed at Schneider Kreuznach from 1985 to 1989 as head of the Optical Design Department, working in the field of optical design. LINOS is a customer of Leica, as well as other optics/optical systems companies.

1. (b) I, Rainer Schuhmann, received a Diploma Degree in Physics from the Technical University of Berlin in 1980. I received my Ph.D. in Physics from the Technical University of Berlin in 1985. During my physics study and Diploma work my education was concentrated in the area of Technical Optics. My Ph.D. thesis was about optical design principles using aspheric surfaces. Speaking and understanding fluently the English language is a standard basis for my daily business.

(see brief biography attached)

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Declaration of Dr. Rainer Schuhmann and Witold Hackemer
US Application Serial No. 09/598,406

2.(a) I, Witold Hackemer, am currently employed as an Optical Designer in the R&D Department in the Business Division Industrial Manufacturing at LINOS Photonics GmbH & Co. KG and have worked at LINOS since 2000. During my tenure at LINOS, I have worked as Senior Optical Designer in the field of optical design, especially lens design, optical system design, and optical technologies. Prior to that, I was employed at Steag-Eta-Optik as Senior Optical Designer from 1997 to 2000.

2. (b) I, Witold Hackemer, received a Diploma Degree in the discipline of Precision Optics/Mechanics from the Polytechnical University of Warsaw in 1978. During my study and examination work I was involved in Optical System Design, Optical Technologies, and Metrology. Speaking and understanding fluently the English language is part of my daily work which includes contacts with colleagues and the reading of technical papers and books.

(see brief biography attached)

3. We have authored or co-authored numerous scientific articles and presentations related to optical design and optical lens design technology. Examples of these papers and talks include principles of lens design and special design solutions (see the attached list).

4. I have reviewed the following documents concerning U.S. Application Serial No. 09/598,406 (the '406 application): the specification and claims as filed on June 21, 2000; a copy of the Office Action dated May 9, 2001, a copy of the response filed on November 9, 2001 (including the amendments to the claims); a copy of the Office Action dated January 10, 2002; a copy of the response filed on June 10, 2002 (including attachments); and a copy of the Advisory Action dated June 19, 2002.

Declaration of Dr. Rainer Schuhmann and Witold Hackemer
US Application Serial No. 09/598,406

5. We are being compensated by Leica for our Declaration at our normal hourly consultation rate of € 100.- per hour.

6. As discussed below, based on the description of the invention provided in the specification of the application and the knowledge of one of ordinary skill in the field of optics, one skilled in the pertinent art could have made and used the invention as defined in claim 1 without undue experimentation.

7. Based on our work experience, our academic experience, and our expertise, a person of ordinary skill in optical design, specifically lens design, as of July 9, 1999, the priority date for the '406 application (corresponding to the filing date of the German priority application no. 199 31 949.9), has the following qualities and background:

- basic education in technical optics
- education in lens design
- experiences / knowledge in optical metrology
- experiences / knowledge in optical technologies (optics production)
- several years of working experience in lens design of imaging systems on an industrial level

As to the education, a person of ordinary skill in optical system/lens design in July 1999 would have a graduate (or equivalent) degree in the field of physics, mathematics, optics, or optical design, and at least four to six years working experience designing optical systems, lenses and/or lens systems.

Driven by the needs for new applications of microscope objectives the optical designer is confronted with the need to develop new lens geometries satisfying new lens correction criteria.

Declaration of Dr. Rainer Schuhmann and Witold Hackemer
US Application Serial No. 09/598,406

The designer of ordinary skill would understand lens system aberration theory and have the necessary skills to lead the design process towards the fulfilment of the lens specification. The designer would base the lens designs on the available state of technology. When building a new lens system, such as a microscope objective, the designer proceeds through the following design steps:

- 1 Establishes a paraxial model for the system,
- 2 Conducts and evaluates existing solutions; i.e. for example, conducts a patent and literature search.
- 3 Develops a starting lens design.
- 4 Conducts preliminary optimisation of starting designs.
- 5 Develops an intermediate design on the basis of some specific preliminary designs.
- 6 Conducts final optimisation of preliminary designs to obtain final designs.
- 7 Proceeds with a tolerance study of the final design, as well as, adjusts the final radii to the existing set of factory test plates.
- 8 The designer establishes a lens compensation scheme based on the results of the tolerance study. A lens compensation scheme allows for the adjustment of lens sub assemblies during production to compensate tolerances of individual lens elements.
- 9 Supports lens mechanical design activities.

Notes: The criteria for completing steps 4 through 6 rely on the assessment of the state of correction of lens aberrations. For example, chromatic lens aberrations can be assessed with the help of the spectral image locus chart. The process of lens optimisation relies on the iteration of design variables resulting in the reduction of lens aberrations.

Declaration of Dr. Rainer Schuhmann and Witold Hackemer
US Application Serial No. 09/598,406

There exist the following commercial standard optical design programs:

Code V, Zemax, Oslo, Sigma, etc. In addition, individual lens manufacturers, such as Zeiss, Rodenstock, Leitz / Leica, and Schneider, have developed their own lens design software for their internal use. Computer design software allows for numerical accuracy never before achievable by the designer. Both individual optical design software and commercial optical design software listed above have been available since prior to July 1999. Consequently, computers have permitted optical designers the achievement of designs with an unmatched degree of complication and accuracy.

With respect to one of the problems discussed in the patent application, chromatic aberrations, prior art solutions for simple lens systems have centered on the development of achromatic lenses. For example, the standard optics textbook, "Optics", Hecht and Zajac, Addison-Wesley Publishing, 1974 edition, discusses a simple focusing scheme at different wavelengths of light at the same focal point. A copy of this discussion, which is known to those of ordinary skill in the art, has been presented to the Patent Office in the response dated June 10, 2002. Thus, a person of ordinary skill in the art would know how to compensate for chromatic aberrations in a simple single lens system. (See the attached table entitled "Literature" which notes references addressing chromatic aberrations).

8. Claim 1 (as amended in the response filed on June 10, 2002) recites:

1. (Twice Amended)

A DUV-capable microscope objective, comprising:

a lens group that comprises a plurality of lens elements made of quartz glass and fluorite, wherein the objective has a DUV focus at a DUV wavelength, $\lambda_{\text{DUV}} \geq 235 \text{ nm}$, wherein the DUV focus encompasses a DUV wavelength region $\lambda_{\text{DUV}} \pm \Delta\lambda$, where $\Delta\lambda = 8 \text{ nm}$, wherein the objective has an IR focus for an IR wavelength $\lambda_{\text{IR}} \geq 760 \text{ nm}$ at the same focal point as the DUV focus at λ_{DUV} , and wherein a penultimate lens element of the lens group comprises a concave configuration on both sides, wherein an object-side outer radius of the penultimate element is smaller than its image-side outer radius.

Declaration of Dr. Rainer Schuhmann and Witold Hackemer
US Application Serial No. 09/598,406

9. We have reviewed the teachings of the '406 application in great detail. The general invention as claimed above is based on a lens design configuration by a special geometry of a set of lens elements in combination with a special selection of the glass materials of these elements. With this configuration the described imaging performance can be achieved. A person of ordinary skill in the art could make and use this invention based solely on the description of the invention in the '406 application combined with that person's knowledge for the following reasons:

(a) Example: First, Tables 1-4 and 6-8 provide detailed optical prescriptions from which the microscope objective of claim 1 can be constructed, and could have been constructed as of July 9, 1999, the priority date of the '406 application. The procedures set forth below were all readily available as of July 9, 1999.

Generally, a person of ordinary skill in the art would review the prescription, for example Table 1, to determine the lens materials and configurations needed. Next, that person would order blanks of the appropriate materials from a commercial vendor. Then, the person would machine and polish the blanks into the appropriate lens configurations, as set forth in the prescription. The materials set forth in Table 1 are commonly used in optical equipment and such blanks are readily available. Any optical shop that makes microscope objectives or similar lenses would have the capability to machine and polish the blanks, using commercially available equipment, in accordance with the prescription. Next, the person of ordinary skill would take the polished lenses and place them in a holder, spacing the lenses in accordance with the prescription. During the assembly process, alignment of the lenses would be carried out in order to ensure that optical axes are in alignment and that proper spacing is provided. Assembly of the

Declaration of Dr. Rainer Schuhmann and Witold Hackemer
US Application Serial No. 09/598,406

lenses in the holder is well within the capability of any optical shop that makes microscope objectives or similar lenses. After assembly, the objective can be tested on a test optical bench to make sure that the intended magnification and other features have been met. Thus, a person of ordinary skill in the art can make an objective in accordance with claim 1 in a straightforward manner, without having to perform any undue experimentation. Based on our experience and the types of materials and lens configurations detailed in Fig. 1, such an objective can be built. Depending on the experience in construction and assembling a microscopic objective of such type the typical timeframe for a person of ordinary skill for construction (mechanical design / system design) would be 1 to 3 months. Building a working prototype for use in a microscope using all finished optical and mechanical parts would be an additional 1 to 2 weeks including testing. These timeframes are typical for the construction and prototyping of microscope objectives based on an existing optical design (optical prescription).

This process can be carried out in a similar manner for any of the seven prescriptions disclosed in the '406 application. Documentations on the performance of the lens objectives are made using two different optical design software programs (see attached figures, corresponding to nomenclature of '406 application). In general, this lens design principle can be used for other variations of the basic design successfully by an experienced optical designer.

(b) Spectral Image Locus Graphs

The spectral image locus curves (see e.g. Figs. 9-12 and 23-25) show the axial location of the microscope objective focal point as a function of wavelength of light. The spectral image locus also depends on the relative ray height in the pupil. The area bound by the two curves on the chart defines a family of curves for relative pupil coordinates varying from zero (for paraxial rays), to maximum pupil size (for rim rays). The spectral image locus curve for paraxial rays is

Declaration of Dr. Rainer Schuhmann and Witold Hackemer
US Application Serial No. 09/598,406

designated with a continuous line and the spectral image locus for rim rays is described with a dashed line. The chart conveys the information that the microscope objective has a common focus at two separate wavelength regions.

The first focus exists in the deep ultraviolet (DUV) spectrum, for example, at 248nm +/- 8nm, and the second focus exists in the IR region for wavelengths in the range from 760nm to 905nm. The information about the two common focus regions contained in the chart of spectral image focus shift is a very important criterion of assessing lens performance. In other words, such a lens objective can be used in a microscope system simultaneously at two wavelengths having a large spectral separation.

Based on the teachings of the '406 application a person of ordinary skill in the art of lens design requires a time frame of about one week for verification and/or testing of the lens design.

The '406 application teaches the necessary starting parameters, including the composition and optical prescription for the penultimate lens, for building a microscope objective/lens assembly having the claimed features. Without these teachings, however, a complete new design of a dry lens objective having, e.g., a focal length of ~1.5mm, a working distance of ~0.2mm, a numerical aperture of ~0.9, a comparable image correction, and the just described chromatic correction at both DUV and at the IR spectral region is not a trivial undertaking and may take years for a person of ordinary skill in the art.

Declaration of Dr. Rainer Schuhmann and Witold Hackemer
US Application Serial No. 09/598,406

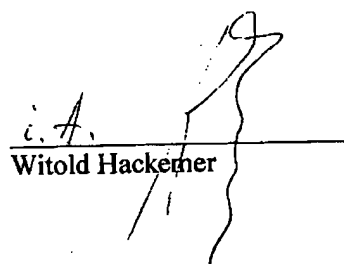
We further declare that all statements made herein of our own knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Executed on:

2003-01-07
Date


Dr. Rainer Schuhmann

2003-01-07
Date


Witold Hackemer